

Response under 37 CFR 1.116
Expedited Procedure
Examining Group 3600
Application No. 09/928,566
Paper Dated May 27, 2005
In Reply to USPTO Correspondence of February 23, 2005
Attorney Docket No. 1692-011111

REMARKS

Claims 1, 2 and 5 are pending in the instant application. Applicant acknowledges with thanks that the Examiner has removed the previously asserted objections Under 35 U.S.C. § 112, respecting the claims. Claims 1, 2 and 5, however, remain rejected Under 35 U.S.C. § 103(a) as obvious over Japanese Patent No. 2-14921 ("JP '921") in view of German Patent No. 743530 ("DE '530") and further in view of Japanese Patent No. 411020723 A ("JP '723") and Kitagawa.

Claims 1, 2 and 5 also stand rejected as obvious over JP '921 in view of U.S. Patent No. 4,093,052 to Falk and further in view of JP '723 and Kitagawa.

Applicant has amended claim 1 to specify that the drive shaft is "supported by a thrust bearing on a frame" and further that the worm body is "able to rotate relative to said drive shaft and able to move in the axial direction of said drive shaft". In light of these amendments and following remarks, Applicant submits that the invention as now claimed would not have been obvious, and the Examiner is thus requested to remove the obviousness rejections.

The Invention Prevents Displacement from Backlash Position

The present invention relates to a multiple lead type worm. In the dividing head of the prior art using the multiple lead type worm, the worm to be meshed with the worm wheel is integrally formed with and thus cannot move with respect to the drive axis portion and the worm teeth portion. As a result, for adjusting a backlash between the worm and the worm wheel, it is necessary to move the drive shaft, with which the worm teeth portion is integrally formed, in its axial direction relative to the frame in order to move the worm teeth to a desired position (see the specification, p. 1, lines 12 - 18). After the movement to the desired position, the bearing housing which rotatably supports the drive shaft on the frame, with the drive shaft held at the desired position, is assembled into the frame by means of assembling screws, thereby completing the adjustment of the backlash (see p. 1, lines 19 - 24, *ibid.*).

Thus, for adjusting a backlash of a dividing head having a worm constituted to have a drive shaft and a worm teeth portion integrally formed, the drive shaft portion with the worm teeth portion integrally formed should be moved in its entirety in the axial direction.

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of the worm body (16) on the drive shaft (18), the worm body (16) is moved to a position where the amount of the backlash between the worm body (16) and the worm wheel (12) becomes optimum, and both are coupled at the optimum position by the assembler (20) (see p. 7, line 24 – p. 8, line 11, *ibid.*).

Thus, according to the present invention, the drive shaft (18) is prevented from moving in its axial direction so that there is no occurrence of displacement of the drive shaft (18) in the axial direction when the worm body (16) is coupled with the drive shaft (18) by the assembler (20). Thus, there is no displacement from the desired backlash adjusting position.

Consequently, in comparison with the prior art, adjustment of the backlash is facilitated by the invention of amended claim 1 without causing any displacement, thereby enabling to divide the circular table (24) at an accurate angle.

The Cited Prior Art

On the other hand, JP '921 describes a multiple dividing head having a plurality of worms (3) and worm shafts (4) respectively to be meshed with worm wheels (2). However, there is no description about forming the worms (3) and the worm shafts (4) to be separate bodies so that the worms (3) are movable in the axial direction of the worm shafts (4) and rotatable with respect to the worm shaft as required by amended claim 1.

Also, while DE '530 as well as Falk, discloses coupling a hollow body with a drive shaft by an assembler, it has no description on separating a worm meshing with a worm wheel into a drive shaft and a worm body, fitting the separated one into the other movably in the axial direction of the one and rotatably so as to facilitate adjustment of backlash.

JP '723 discloses a worm gear structure capable of adjusting a backlash between a worm of a steering wheel and a worm wheel. JP '723, however, merely discloses a prior art mentioned in the specification of this application. Particularly, JP '723 discloses a worm (12) of which the thickness of a tooth continuously changes along a gear trace, and means for supporting the worm shaft (13) slidably in the axial direction. Also, the supporting means includes bearings (14, 15) for supporting the end of the worm shaft (13) and means (18, 20) for regulating the axial position of the worm shaft (13) for adjustment of backlash. The worm (12), however, is not provided rotatably about the worm shaft (13) or

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Also, the bearing housing supporting the drive shaft portion should be fixed on the frame so that the worm teeth portion is placed at the desired position.

In a worm having a drive shaft portion and a worm teeth portion integrally formed, however, the drive shaft portion with which the worm teeth portion is integrally formed is prone to move from its predetermined position when assembling by screws to fix the bearing housing on the frame, namely, when combining rotatably the drive shaft portion of the worm with the frame. This movement of the drive shaft portion causes a displacement in the backlash amount to be adjusted. It was not easy, therefore, to position the worm at the desired position without causing any change from the adjusted position of the backlash, and it was not easy to make an accurate backlash adjusting operation because of a change (displacement) in the amount of the backlash caused when assembling the drive shaft portion of the worm into the frame (p. 2, lines 2 - 9, *ibid.*)

An object of the present invention is, therefore, to facilitate an adjusting operation of a backlash between a worm and a worm wheel.

To attain this object, the dividing head in the present invention comprises: a worm wheel (12) to be assembled into a worm wheel shaft (14) to which a circular table (24) is attached; a worm body (16) having a multiple lead type meshing portion to mesh with the worm wheel shaft (14) and having a hollow portion (46); a drive shaft (18) fitted to the hollow portion of the worm body; and an assembler (20) having an annular portion (cylinder) (50) which couples the drive shaft (18) and the worm body (16) by frictional engagement.

The drive shaft (18) is rotatably supported on the frame (30) through thrust bearings (29) (see p. 5, lines 18 - 20, *ibid.*). The thrust bearings permit rotation about the axis of the drive shaft (18) but regulate movement in its axial direction, so that the drive shaft (18) is prevented from moving in its axial direction.

Importantly, the worm body (16) is fitted into the drive shaft (18), which is restrained from the axial movement, so as to move in the axial direction of the drive shaft (18) and rotate (see p. 2, the last line - p. 3, line 2, *ibid.*).

According to the dividing head of the present invention, when the worm body (16) is rotated about the drive shaft (18) in a state that the worm body (16) and the drive shaft (18) are uncoupled, the worm body (16) meshing with the stationary worm wheel (12) moves in the axial direction of the drive shaft (18) relative to the drive shaft (18). By this movement

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slidable in the axial direction of the worm shaft, and both are formed integrally. In adjusting a backlash, therefore, the worm shaft (13) with which the worm (12) is integrally formed should be moved in its entirety in the axial direction of the worm shaft. As a result, as mentioned above, when coupling the worm shaft with the support means by the regulating means, displacement is prone to be caused in the adjusted backlash. There is no description about, to prevent this displacement, making the worm (3) and the worm shaft (4) separate bodies and, fitting the worm (3) rotatably and movable in the axial direction of the worm shaft (4).

Also, the Notice of Reasons for Rejection refers to Kitagawa (US Pat. 5,188,004) in the third line from the bottom on page 2, but Kitagawa Patent only shows a worm shaft (24a) which is integrated with a worm (24), and has no description about fitting the worm (3) with the worm shaft (4) movably and rotatably in the axial direction of the worm shaft (4).

The present invention, because of its unique constitution, enables to position the worm body at an optimum backlash adjusting position without moving the drive shaft of the worm in the axial direction. This facilitates backlash adjustment and enables division of the circular table (24) into an accurate angle.

Consequently, the present invention would not have been obvious over the respective combined cited references.

Further, the Examiner contends that it would have been obvious

(1) to apply the coupling/uncoupling means (assembler) of DE '530 to the worm body of the dividing head described in JP '921;

(2) to apply the coupling/uncoupling means (assembler) of Falk to the worm body described in Kitagawa; and

(3) to apply the coupling/uncoupling means (assembler) of Falk to the worm body of the dividing head described in JP '921.

However, as mentioned above, JP '921 and Kitagawa disclose only integrally assembling a worm body into a drive axis immovably and do not suggest enabling to adjust the position of a worm relative to the drive axis as now set forth in claim 1.

Therefore, there is no conceiving of such a constitution as movably assembling a worm body into a drive axis, even by taking DE '530 or Falk into account.

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Accordingly, it is not conceived, either, of applying the assembler described in DE '530 or Falk into the worm body. Consequently, the Examiner's judgments in above (1), (2) and (3) are mistaken.

In light of the above amendments and remarks, claim 1 (and dependent claims 2 and 5) are now deemed allowable.

Respectfully submitted,

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